

forecast, and during the early days of the ensuing week predicted a continuation of the mild spell for a considerable period. The long-range forecast was of great service to shippers of perishable goods, railroads, and other transportation companies, and newspapers commented on it favorably.—*H. J. Cox, Professor of Meteorology.*

Denver District.—No cold waves occurred during the month, and no warnings were issued except at the close of the month. At 8 p. m. on the 29th an anticyclonic area of moderate intensity was spreading southward over Montana and cold-wave warnings were issued for eastern Colorado. These warnings were verified by a 24-hour fall in temperature in eastern Colorado of 20° to 30°, and were followed within 36 hours by temperatures ranging from 5°F. to 10°F.—*Frederick W. Brist, Assistant Forecaster.*

New Orleans District.—Cold-wave warnings were issued on the morning of February 12 for Oklahoma and the northwestern portion of east Texas, were extended in the afternoon over the northeastern and southwestern portions of east Texas and northwestern Louisiana, and were extended at night to the Gulf coast. Subsequent conditions justified the warnings. Storm warnings were ordered for the Galveston section on the 12th and storm winds occurred during the display. No general storm occurred during the month. With the exception of the cold wave that passed over the district from the 11th to 13th moderate weather conditions prevailed during the month.—*I. M. Chne, District Forecaster.*

Portland, Oreg., District.—Owing to interruptions in the telegraph and cable services during the month, the making of forecasts was encumbered with difficulties. A sleet storm on the 2d prostrated the wires for 20 miles or more in all directions from Portland and the damage was equally as severe in the neighborhood of Seattle and Tacoma. It was a week or ten days after the storm before the telegraph and telephone companies were able to resume business on a normal basis. Besides the interruption caused by the sleet storm, reports from Alaska were missing for nearly the entire month due to cable trouble, and many reports from the stations in the Aleutian Islands were not received during the first half of the month, which was the time when they were most needed. Storm warnings were issued on the 1st, 5th, 8th, 9th, 13th, and 29th; small-craft warnings on the 7th, 13th, 17th, and 28th. Only one general storm warning was issued, the others being for small areas where the conditions were apparently threatening, and most of these threatening conditions did not develop verifying velocities. The general storm warning was issued on the evening of the 8th to coast stations, and extended the next morning to inland seaports. It was followed by maximum velocities ranging from 36 to 60 miles an hour, and was especially severe on Puget Sound. Live-stock warnings were issued on the 3d, 4th, 5th, 28th, and 29th. Live-stock warnings are a new feature, and those issued on the 3d, 4th, and 5th were to one locality upon special request and in advance of the authorization for the service. They were fully verified and favorably commented on by the recipient. Live-stock warnings were again issued on the 28th to all but four distribution centers, and on the next morning these four centers were notified of expected cold, stormy weather. This warning was fully verified and a newspaper clipping informs us that it was of "much value" to stock raisers. Warnings were issued that the hazard from avalanches would be greatly increased during the period from the 8th to 10th. This class of warnings is also a new departure, and pertained to the increase

of the hazard from avalanches. These warnings were issued on the 7th, 8th, and 9th, the first one being an advanced notice of the approach of warmer, windy weather with rain, which is the kind of weather that always causes numerous avalanches when the snow is heavy in the mountains. The subsequent avalanche warnings were for the purpose of calling attention to the fact that the danger period had not yet passed. These warnings were fully justified, judging from newspaper items which contained many notices of slides and avalanches during the period covered by them.—*E. A. Beals, District Forecaster.*

San Francisco District.—There were no storms of a dangerous character nor were there any damaging frosts.—*G. H. Willson, District Forecaster.*

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RELATION BETWEEN RAINFALL AND SYNOPTIC WINDS.

H. HELM CLAYTON, In Charge of Forecasting.

[Argentine Meteorological Office, Buenos Ayres. MS. recorded Feb. 24, 1916.]

Rainfall is one of the most important elements, yet it occurs in such irregular, spotted areas as to defy even the most skilled forecaster. For example, on the weather map for May 22, 1913, shown in the accompanying figure figure H. H. C. 1 (XLIV-22), there is an area of rain in the Lake Region and New England, another in the lower Mississippi Valley, and a third on the Pacific coast.

In seeking more definitely the conditions which attend rain, it is well to consider its physical causes. Rain is caused by the chilling of moist air below the point of saturation, so that a part of the moisture falls out. Experience indicates that the most potent if not the only cause of this cooling is the expansion of ascending air as it comes under diminished pressure aloft. The ascent of the air may be induced by: (1) Topography, as for example where air is forced over mountain ranges; (2) heating at the ground, which determines the formation of local ascending currents resulting in cumulus clouds and local showers; (3) converging or opposing winds determined by horizontal differences of temperature and pressure.

The first of these is a climatic factor which a forecaster needs to keep in mind, and the second is the cause of occasional showers, specially in summer, but experience shows that the third is the main cause of our ordinary rainstorms.

When winds are diverging a descent of air is indicated and consequently fair weather, because descending winds are dry. On the contrary, when winds are converging ascending air is indicated and consequently expansion and cooling, resulting in clouds and rain.

The factors determining the intensity of the rainfall are, (1) the angle of convergence, (2) the speed of the wind, (3) the moisture content of the air, and (4) the topography. Coefficients would need to be determined for all these in a proper formula.

The wind is usually indicated on the weather maps to eight points of the compass, and this permits a scale of four steps both for diverging and converging winds, thus (1) ↑ ↗, (2) ↑ →, (3) ↑ ↘, (4) ↑ ↓, for diverging, and a similar scale for converging winds. If on the weather map the diverging winds are marked with red and the converging winds with blue in accordance with the above scale, it becomes apparent that the red marks are located, as a rule, in regions of fair weather and the blue marks in

regions of clouds and rain. See the accompanying chart of May 22, 1913 (fig. 1, XLIV—22).

Studies of this kind render it evident that a condition to be considered in forecasting rainfall is that of converging winds.

In figure 1 the areas of converging winds exceeding 1 on the scale are inclosed with blue lines and the areas of rain are indicated by the symbol R. Since the convergence of the wind on which the rainfall depends is determined by the distribution of pressure, it is possible from a chart showing the anticipated distribution of pressure to forecast both wind and rain.

Plotting wind arrows along the lines of equal pressure according to the relation known to exist in the Northern Hemisphere (not considering speed), the region of converging winds can be easily selected and indicated by shaded areas. In this way the shaded area becomes the predicted area for rainfall.

The method used by me in the Argentine weather service is to predict the pressure distribution for the succeeding day and then draw in the winds and areas of rain. Experience teaches, however, that rain will not result from converging winds in areas where the [relative] humidity is low (60 per cent or less) and the rain area is omitted in such areas. Doubtless such forecasts will increase in accuracy with increasing knowledge and improvement in the method.

Plotting the divergence of the wind in red and the convergence in blue discloses the fact that diverging winds are the usual condition around centers of high pressure and converging winds around centers of low pressure. But this condition is frequently reversed. In the case of reversal there is rain within the area of high pressure where there exist converging winds, and fine weather in the low pressure where there exist diverging winds. Another example of the relation of rainfall to converging winds is shown in the accompanying figure 2 (XLIV—23) for May 3, 1913.

It is not meant to be understood that converging winds are the only factor in rain production. Temperature and humidity are also important factors. It will perhaps be possible to illustrate the effect of temperature distribution at some later date.

The effect of topography appears evident in figure 3 (XLIV—24). Here a broad stream of air is being drawn from the ocean up the gentle slopes of the Appalachian Mountains by a storm of unusual violence and extent, resulting in a long strip of rain along the eastern slope while on the western side of the mountain range where the air is descending the slopes, the sky remains clear notwithstanding the convergence of the wind. On the other hand with a well-defined low pressure over the ocean it frequently clears on the eastern slopes of the mountain while it is still raining or snowing on the western.

LONG-RANGE FORECAST OF THE WINTER MINIMUM TEMPERATURE FOR HAMADA, JAPAN.¹

By M. ISIDA.

In western Japan there is a well-tried weather proverb current among laymen, to the effect that a severe winter is preceded by an abnormally hot summer.

The author of the paper here abstracted, has for his object the testing of this piece of weather lore by means of

the data from instrumental observations, and he has arrived at the striking result that the minimum temperature of the coming winter [at least for the locality studied] can be calculated with great accuracy from the mean temperature of the past summer.

TABLE 1.—Observed and computed winter minimum temperatures at Hamada, Japan, 1893–1913.

Year.	Mean summer temperature, T .	Winter minimum temperature.		$t_o - t_c$.
		Observed t_o .	Calculated t_c .	
	°C.	°C.	°C.	°C.
1893	21.8	-3.7	-3.2	-0.5
1894	23.5	-8.7	-7.7	-1.0
1895	22.1	-4.3	-4.0	-0.3
1896	22.5	-5.3	-5.1	-0.2
1897	21.3	-2.1	-1.8	-0.3
1898	21.9	-3.6	-3.5	-0.1
1899	22.2	-4.2	-4.2	0.0
1900	22.2	-3.2	-4.2	1.0
1901	21.5	-2.0	-2.3	0.3
1902	21.5	-3.2	-1.9	-1.3
1903	22.3	-3.6	-4.5	0.9
1904	21.6	-2.3	-2.6	0.3
1905	22.3	-4.6	-4.6	0.0
1906	21.6	-2.0	-2.6	0.6
1907	21.8	-3.7	-3.2	-0.7
1908	21.8	-2.1	-3.1	-1.0
1909	22.4	-4.6	[-4.8]	[-0.2]
1910	22.0	-3.8	-3.8	0.0
1911	21.3	-2.8	-1.9	-0.9
1912	22.0	-2.9	-3.6	0.7
1913	21.0	-0.9	-1.1	0.2
1914	22.9			

¹ Figures in brackets were recomputed.—C. A., Jr.

Table 1 gives in its second column the mean air temperature (T) at Hamada, on the west coast of Japan [long. $132\frac{1}{2}^\circ$ E.; lat. 35° N.], for its warm season or about May 11 to September 20. In the 3d, 4th, and 5th columns are given, respectively, the observed minimum temperature, t_o , of the following winter, the calculated minimum temperature, t_c , as obtained by means of the author's equation $t = 55.44 - 2.69 T$, and the difference $t_o - t_c$.—*T. O. [kada]*.

CIRRUS DIRECTIONS AT MELBOURNE AND STORMS AFFECTING VICTORIA.¹

By E. T. QUAYLE, B. A., Assistant.

[Commonwealth Bureau of Meteorology, Melbourne, Victoria.]

(Abstracted for the REVIEW, by A. J. Henry.)

Systematic observations of the direction of movement of cirrus clouds have been made in Melbourne for many years. The results of these observations for the period 1895 to 1912 have been correlated with the various cyclonic systems which affect the weather of extreme southeastern Australia.

Mr. Quayle groups the cyclones of Australia under eight types, of which by far the greater number belong to the type Antarctic V-depressions. These are first observed as they round Cape Leeuwin, distant from Melbourne about 1,800 miles. Cirrus observations at Melbourne are evidently made with considerable precision and probably by means of a nephoscope. The manner of grouping the data, as explained by the author, was about as follows:

¹ Slightly rearranged and reprinted from the English abstract in Journal of the Meteorological Society of Japan, Feb., 1916, 28, 9–10.

¹ Quayle, E. T. Relation between cirrus directions as observed in Melbourne and the approach of the various storm systems affecting Victoria. Melbourne, May, 1915. 1 pl., 46 figs., 27 p. 4°. (Commonwealth Bureau of Meteorology, Bulletin No. 10.)